CLAIMS:

1. A method for applying digital watermarking image data or digital watermarking audio data to an unlabelled digital image, audio, or video data sample, said method including the steps of:

a) inputting a set of unlabelled digital data and a set of digital watermark data;

b) formatting the unlabelled digital data into a format suitable for orthogonal transformation;

c) performing an orthogonal transformation on the formatted unlabelled data to produce a set of unlabelled data transform coefficients;

d) formatting the digital watermark data into a format suitable for orthogonal transformation;

e) performing an orthogonal transformation on the formatted watermark data to produce a set of watermark data transform coefficients;

f) for each watermark data transform coefficient, allocating an unlabelled data transform coefficient to be replaced and replacing the respective unlabelled data transform coefficients to produce a labelled set of data transform coefficients;

g) storing the locations into which watermark data transform coefficients were encoded in the set of labelled data transform coefficients to generate a unique key for future decoding of the watermark data;

h) performing an inverse orthogonal transformation on the labelled data transform coefficients to convert them into a set of labelled digital data having a form resembling the original unlabelled digital data.

2. The method of claim 1 wherein the step of formatting the watermark data includes the step of mapping the set of watermark data into a two-dimensional matrix.

3. The method of claim 2 wherein the step of formatting the watermark data includes the step of dividing the two-dimensional matrix of watermark data into smaller sub-blocks and the step of performing the orthogonal transformation on the watermark data involves performing the orthogonal transform on each sub-block of the watermark data, such that the watermark data transform coefficients are organised in sub-blocks.

4. The method as claimed in claim 3, including an ordering step in which each sub-block of the watermark data transform coefficients are reordered into a one-dimensional array in approximately increasing frequency order, as hereinbefore

defined, prior to replacement of the allotted unlabelled data transform coefficients with the watermark data transform coefficients.

5. The method of claim 4, in which the step of reordering the watermark data transform coefficients of each sub-block is achieved by performing a zig-zag scan of the watermark data transform coefficients in the respective sub-block.

6. The method of claim 4, in which the step of reordering the watermark data transform coefficients of each sub-block is achieved by performing a radial scan of the watermark data transform coefficients in the respective sub-block .

7. The method as claimed in claim 4, 5 or 6, wherein after the watermark data transform coefficients of each sub-block are reordered into a one-dimensional array and before the replacement of unlabelled data transform coefficients with the watermark data the watermark data transform coefficients of each one-dimensional array are rescaled.

8. The method as claimed in claim 7, wherein the rescaling is performed using a scaling function that reduces the magnitude of lower frequency coefficients of the one-dimensional array by a greater amount than higher frequency coefficients of the respective array.

9. The method of claim 8, wherein the scaling function has an exponential characteristic.

10. The method of any one of claims 4 to 9, including the step of dividing the reordered watermark data transform coefficients of each sub-block into segments for subsequent replacement into the set of transformation coefficients of the unlabelled data.

11. The method as claimed in any one of claims 1 to 10, wherein the step of formatting the unlabelled data includes the step of mapping the set of unlabelled data into a two-dimensional matrix.

12. The method of claim 11 wherein the step of formatting the unlabelled data includes the step of dividing the two-dimensional matrix of unlabelled data into smaller sub-blocks and the step of performing the orthogonal transformation on the unlabelled data involves performing the orthogonal transform on each sub-block of the unlabelled data, such that the unlabelled data transform coefficients are organised in sub-blocks.

13. The method of claim 12, including a first ordering step in which each sub-block of the unlabelled data transform coefficients are reordered into a one-dimensional array in approximately increasing frequency order, as hereinbefore

defined, prior to replacement of allocated unlabelled data transform coefficients with watermark data transform coefficients, and a second ordering step in which each of the one-dimensional arrays of the labelled data transform coefficients are reordered into sub-blocks using an inverse reordering to that of the first ordering step.

14. The method of claim 13, wherein the first ordering step is achieved by performing a zig-zag scan of each sub-block of the unlabelled data transform coefficients and the second ordering step is achieved by performing an inverse zig-zag scan of each one-dimensional array of the labelled data transform coefficients.

15. The method of claim 13, wherein first ordering step is achieved by performing a radial scan of each sub-block of the unlabelled data transform coefficients and the second ordering step is achieved by performing an inverse radial scan of each one-dimensional array of the labelled data transform coefficients.

16. The method of claim 13, 14 or 15, including the step of, for each one-dimensional array of unlabelled data, determining a location beyond which the ac energies will fall below a certain threshold value and selecting transform coefficients beyond that location for replacement by transform coefficients of the watermark data.

17. The method of claim 16, including the step of calculating the mean and variance values of the ac energies from the orthogonal transformation coefficients for each one-dimensional array of unlabelled data and calculating the threshold value as a function of the mean and variance values.

18. The method as claimed in any one of claims 12 to 17, including the step of, for each one-dimensional array of the unlabelled data, allocating a segment of the orthogonally-transformed watermark data that will be encoded in that sub-block, if any.

19. The method as claimed in any one of claims 1 to 18, wherein the orthogonal transform performed on the unlabelled data is one of: a Discrete Cosine Transform (DCT); a Fourier transform; a Walsh-Hadamard transform; a Haar transform; a sine transform; and a Wavelet transform, and the inverse transform is respectively; an inverse DCT; an inverse Fourier transform; an inverse Walsh-Hadamard transform; an inverse Haar transform; an inverse sine transform; and an inverse Wavelet transform.

20. The method as claimed in claim 19, wherein the orthogonal transform performed on the unlabelled data is a Discrete Cosine Transform (DCT) and the inverse transform is an inverse DCT.

21. The method as claimed in any one of claims 1 to 20, wherein the orthogonal transform performed on the watermark data is one of: a Discrete Cosine

Transform (DCT); a Fourier transform; a Walsh-Hadamard transform; a Haar transform; a sine transform; and a Wavelet transform.

22. The method as claimed in claim 21, wherein the orthogonal transform performed on the watermark data is a Discrete Cosine Transform (DCT).

23. The method as claimed in any one of claims 1 to 22, including the further step of allocating in a structured manner a segment of the orthogonally-transformed unlabelled data that will be replaced by each segment of orthogonally transformed watermark data.

24. The method as claimed in any one of claims 1 to 22, including the further step of allocating in a random manner a segment of the orthogonally-transformed unlabelled data that will be replaced by each segment of orthogonally transformed watermark data.

25. The method as claimed in any one of the preceding claims wherein the set of unlabelled digital data is obtained from a sample stream representing a digitised grayscale or colour image.

26. The method as claimed in claim 25, wherein the digitised grayscale or colour image is obtained from a digital still camera or a digital image scanner.

27. The method as claimed in any one of claims 1 to 24, wherein the set of unlabelled digital data is obtained from a sample stream representing digitised video.

28. The method of claim 27, wherein the unlabelled digitised video is obtained from a Data Storage Medium (DSM), or a real time digital data source.

29. The method as claimed in claims 1 to 28, wherein the labelled digitised video is subsequently transmitted over a digital communications channel.

30. The method as claimed in any one of claims 1 to 28, wherein the labelled digitised video is subsequently recorded on a digital recording medium.

31. The method as claimed in claim 30, wherein the digital recording medium is one of: a Video Compact Disc (VCD); a Laser Disc (LD); a Digital Versatile Disc (DVD); a digitised movie and a still image contained within a video game, video-on-demand or other software.

32. The method as claimed in any one of claims 1 to 24, wherein the unlabelled digital data is obtained from a sample stream representing one or more channels of digitised sound or music.

33. The method of claim 32, wherein the unlabelled digitised sound or music is obtained from one of: a master recording on digital audio tape played on a digital tape recorder; and a master recording on an analog audio tape played on an analog tape recorder and digitised via a digitising interface.

34. The method as claimed in any one of claims 32 to 33, wherein the labelled digitised sound or music is subsequently recorded on a digital recording medium.

35. The method as claimed in claim 34, wherein the digital recording medium is one of: a compact Disc (CD); a Digital Audio Tape (DAT); a Laser Disc (LD); a Video Compact Disc (VCD).

36. The method as claimed in any one of the preceding claims wherein the watermark digital data includes one or more of the following data items: an owner's logo; an owner's trademark; a personal identification; an artist's recorded voice; or general terms for publisher distribution.

37. A method for extracting digital watermarking image data or digital watermarking audio data from a digital image, audio, or video data sample, said method including the steps of:

a) inputting a set of labelled digital data and unique key data containing information of locations of watermark data imposed as a label on the labelled digital data;

b) mapping the set of labelled digital data into a format suitable for orthogonal transformation;

c) performing an orthogonal transformation on the formatted labelled data to produce a set of labelled data transform coefficients;

d) using the unique key to extract transform coefficients of orthogonally transformed watermark data from the locations in the set of labelled data transform coefficients specified in the key;

e) using an inverse orthogonal transformation on the transformed watermark data to retrieve the embedded watermark data.

38. The method of claim 37 wherein the step of formatting the labelled data includes the step of mapping the set of labelled data into a two-dimensional matrix.

39. The method of claim 38 wherein the step of formatting the labelled data includes the step of dividing the two-dimensional matrix of labelled data into smaller sub-blocks and the step of performing the orthogonal transformation on the labelled data involves performing the orthogonal transform on each sub-block of the labelled data, such that the labelled data transform coefficients are organised in sub-blocks.

40. The method as claimed in claim 39, including the step of ordering the orthogonal transformation coefficients of the labelled data in each sub-block into a one-dimensional array in approximately increasing frequency order, as hereinbefore defined, prior to extraction of the watermark data coefficients.

41. The method as claimed in claim 40, wherein the ordering step is achieved by performing a zig-zag scan of each sub-block of orthogonally transformed labelled data.

42. The method as claimed in claim 40, wherein the ordering step is achieved by performing a radial scan of each sub-block of orthogonally transformed labelled data.

43. The method of any one of claims 37 to 42, wherein after extraction of the watermark transform coefficients from the orthogonally transformed labelled data, the extracted watermark data transform coefficients are arranged into a number of one-dimensional arrays corresponding to the number of sub-blocks used in the process of encoding the watermark data into the labelled data and each one-dimensional array is then reordered into a two-dimensional sub-block prior to performing the inverse orthogonal transform on the watermark data transform coefficients in each sub-block.

44. The method of claim 43, wherein the reordering of each one-dimensional array of watermark data transform coefficients into a respective sub-block is achieved by performing an inverse zig-zag scan.

45. The method of claim 43, wherein the reordering of each one-dimensional array of watermark data transform coefficients into a respective sub-block is achieved by performing an inverse radial scan.

46. The method as claimed in any one of claims 37 to 45, wherein the transform coefficients of the watermark data embedded in the labelled digital data are compressed using a first scaling function and the method includes the step of expanding the compressed watermark data prior to the inverse orthogonal transformation using a second scaling function which is an inverse of the first scaling function.

47. The method of claim 46, wherein the inverse scaling function increases the magnitude of lower frequency coefficients of each one-dimensional array of watermark data to a greater extent than it increases the magnitude of the higher frequency coefficients of the respective one dimensional array.

48. The method of claim 46, wherein the first scaling function has an exponential characteristic and the second scaling function has an inverse exponential characteristic.

49. The method as claimed in any one of claims 37 to 48, wherein the orthogonal transform performed on the labelled data is one of: a Discrete Cosine Transform (DCT); a Fourier transform; a Walsh-Hadamard transform; a Haar transform; a sine transform; and a Wavelet transform.

50. The method as claimed in claim 49, wherein the orthogonal transform performed on the labelled data is a DCT.

51. The method as claimed in any one of claims 37 to 50, wherein the inverse orthogonal transform performed on the watermark data is one of: an inverse Discrete Cosine Transform (DCT); an inverse Fourier transform; an inverse Walsh-Hadamard transform; an inverse Haar transform; an inverse sine transform; and an inverse Wavelet transform.

52. The method as claimed in claim 51, wherein the inverse orthogonal transform performed on the watermark data is an inverse DCT.

53. The method as claimed in any one of claims 37 to 52, including the further step of displaying the watermark data samples for immediate examination or authentication.

54. The method as claimed in any one of claims 37 to 52, including the further step of storing the watermark data samples for future examination or authentication.

55 The method as claimed in any one of claims 37 to 54, wherein the labelled digital data is obtained from a sample stream representing a digitised grayscale or colour image.

56. The method as claimed in claim 55, wherein the labelled digitised grayscale or colour image is obtained from a digital still camera or a digital image scanner.

57. The method as claimed in any one of claims 37 to 54, wherein the labelled digital data is obtained from a sample stream representing digitised video.

58. The method of claim 57, wherein the labelled digitised video is obtained from one of: a Video Compact Disc (VCD) played on a VCD player; a Laser Disc (LD) played on a LD player; a Digital Versatile Disc (DVD) played on a DVD player; a digitised movie or still image contained within a video game or other software or a digital signal transmitted over a communications channel.

59. The method as claimed in any one of claims 37 to 54, wherein the labelled digital data is obtained from a sample stream representing one or more channels of digitised sound or music.

60. The method of claim 59, wherein the labelled digitised sound or music is obtained from one of: a Compact Disc (CD) played on a CD player; a Digital Audio Tape (DAT) played on a DAT player; a Laser Disc (LD) played on a LD player; from a Video Compact Disc (VCD) played on a VCD player.

61. The method as claimed in any one of claims 37 to 60, wherein the watermark digital data includes one or more of the following data items: an owner's logo; an owner's trademark; a personal identification; an artist's recorded voice; and general terms for publisher distribution.

62. An apparatus for applying digital watermarking image data or digital watermarking audio data to an unlabelled digital image, audio, or video data sample, said apparatus including:

a) input means arranged to input a set of unlabelled digital data;

b) processing means arranged to process the unlabelled digital data to encode watermark data into the unlabelled data to form a set of labelled digital data; and

c) output means arranged to output the labelled digital data to a communication or storage medium,

wherein the processing means is arranged to perform the method as claimed in any one of claims 1 to 36.

63. An apparatus for extracting digital watermarking image data or digital watermarking audio data from a labelled digital image, audio, or video data sample said apparatus including:

a) input means arranged to input a set of labelled digital data;

b) processing means arranged to process the labelled digital data to extract watermark data encoded into the labelled digital data; and

c) output means arranged to output the extracted watermark digital data to a display or storage means,

wherein the processing means is arranged to perform the method as claimed in any one of claims 37 to 61.

64. A digital recording stored on any digital recording medium, the recording comprising a set of digital image, audio, or video data labelled with a watermark comprising a set of digital watermark image data or a set of digital watermark audio data, the set of labelled digital data being created by encoding a set of unlabelled digital data with the set of digital watermark data using the method as claimed in any one of claims 1 to 36.

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